RELATIVE PERFORMANCE AND CATCHABILITY OF STOCKED DIPLOID AND TRIPLOID WESTSLOPE CUTTHROAT TROUT IN SMALL CLEARWATER BASIN LAKES

W.L. Knotek and W. Schreck, Montana Fish, Wildlife & Parks
A. Smith and T. Lipscomb, Washoe Park State Fish Hatchery

Background

Westslope cutthroat trout (WCT, *Oncorhynchus clarki lewisi*) are currently the most important sport species stocked in high and middle elevation lakes in western Montana. Montana Fish, Wildlife, & Parks (MFWP) stocks hundreds of lakes with this species using the agency's M012 strain, which was developed using a range of wild stocks confirmed to be genetically diverse and compatible with other regional non-introgressed populations. Despite high suitability for stocking, MFWP staff are still hesitant to stock or recommend stocking of viable (diploid) WCT in some situations because of potential changes to the genetic composition of adjacent, hydrologically connected native populations. The same concern applies to stocking private fish ponds that are linked or adjacent to waters supporting wild, non-introgressed cutthroat trout.

Use of sterile (triploid) fish is one option for stocking in sensitive areas where impacts to the genetic integrity of wild populations is a concern. However, some evidence suggests that triploid trout may exhibit reduced performance relative to diploid individuals from the same source. For instance, growth and survival of diploid and triploid WCT reared in the hatchery were assessed by Boyer et al. (2012) using paired trials. These evaluations indicated a performance advantage for early life stages of diploid WCT in hatchery rearing facilities. Similarly, Koenig and Meyer (2011) observed reduced survival rates and return to anglers for triploid catchable rainbow trout (*Oncorhynchus mykiss*) relative to concurrently planted diploid stocks in several Idaho lakes and reservoirs.

This study is an extension of similar published assessments, where we evaluated the relative performance of triploid (3N) and diploid (2N) WCT in side-by-side field trials at several natural lakes. After several year classes of hatchery reared fingerlings were planted in lakes occurring over a range of elevations, we directly compared growth, survival, and susceptibility to angling for sterile and viable fish to help inform management decisions regarding WCT stocking in western Montana.

Study Area and Methods

Four lakes (16-103 acres) in the Clearwater Basin of Western Montana were selected as study sites for our paired trials: Rainy Lake, Hidden Lake, Clearwater Lake, and Spook Lake (Figure 1). These lakes were chosen because they vary in elevation, already supported WCT populations and WCT natural reproduction was believed to be minimal.

Fish species composition varies somewhat among lakes. Hidden and Spook Lakes support only WCT, but Clearwater Lake also contains illegally introduced brook trout (*Salvelinus fontinalis*) that make up a significant portion of the fish biomass. Rainy Lake contains several species other than WCT, including native bull trout (*Salvelinus confluentus*) and longnose sucker (*Catostomus catostomus*), as well as introduced yellow perch (*Perca flavescens*), brook trout, and pumpkinseed sunfish (*Lepomis gibbosus*).

All lake study sites were actively stocked with WCT and support existing fisheries. Established stocking rates and frequency were maintained during our trials, except that plants were split evenly between triploid and diploid fish (Table 1). Lakes were stocked annually for 4-5 years (2011-2015), with the exception of Spook Lake, which was stocked every other year.

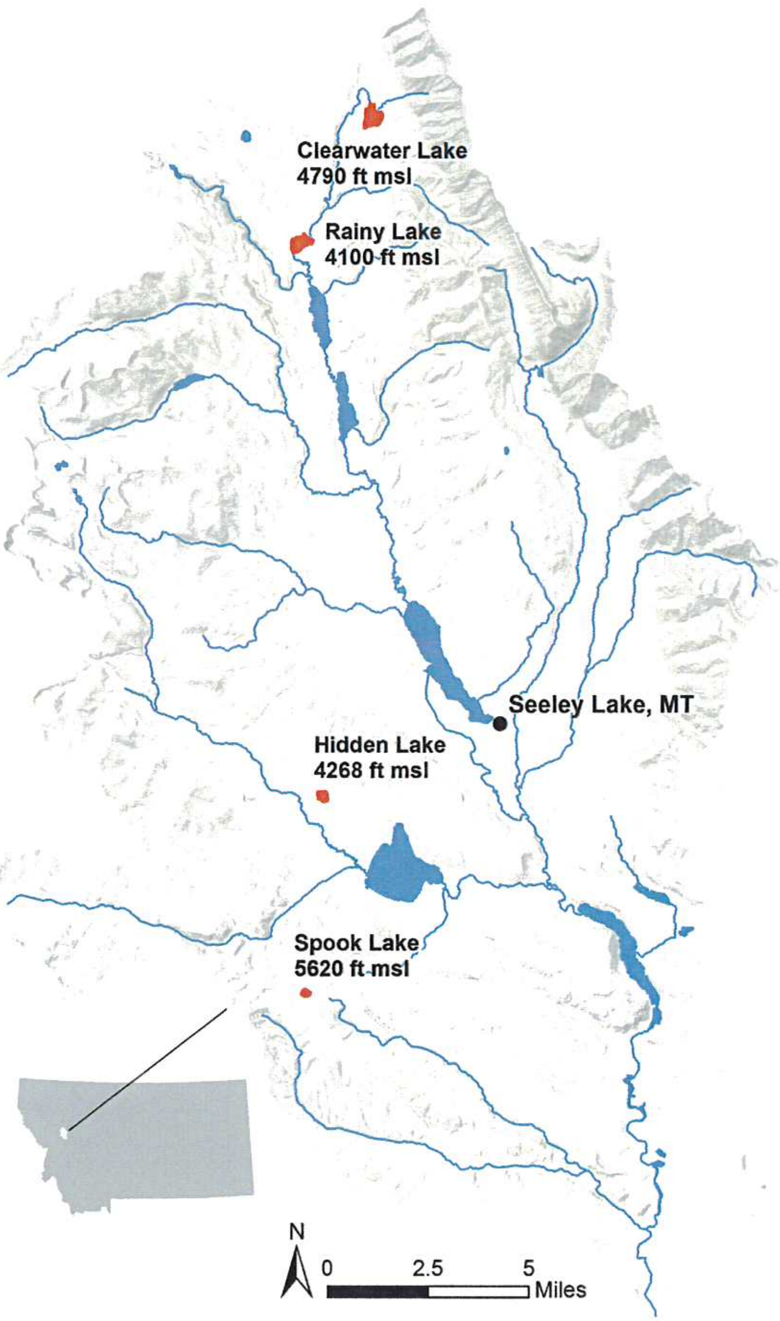


Figure 1. Location of study sites (lakes in red) in the Clearwater Basin for trials comparing performance and catchability of diploid and triploid westslope cutthroat trout.

Cutthroat Trout Production, Marking, and Stocking

Sterile and viable WCT used in this study were progeny of existing M012 brood stock at the Washoe Park State Fish Hatchery. Immediately after spawning, egg lots were split and triploid WCT were produced using pressure treatments on fertilized eggs (Angela Smith, Washoe Park State Fish Hatchery Manager, personal communication). Diploid and triploid cutthroat trout were then propagated for ~ 12 months under identical conditions and at similar densities in adjacent hatchery rearing tanks and raceways (Figure 2).

Prior to stocking, all fish were marked using feed with an oxytetracycline (OTC) supplement that allowed us to distinguish stocked fish from wild (naturally produced) individuals in study lakes. In addition, adipose fins were removed from all triploid (sterile) WCT to distinguish them from diploid individuals (Figure 2).

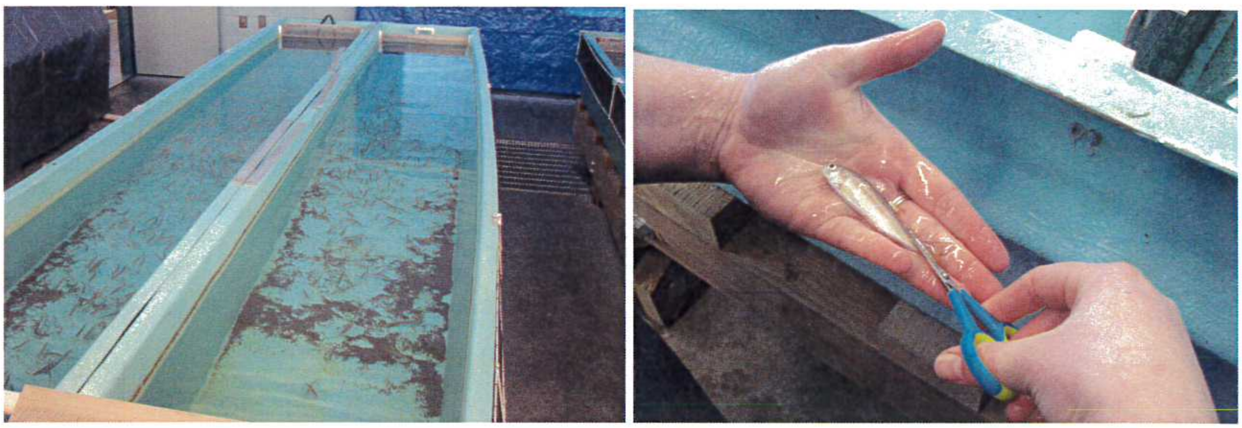


Figure 2. Hatchery raceways with diploid and triploid westslope cutthroat trout (left). Adipose fins were clipped on triploid individuals for easy identification (right).

WCT planted as part of the study were hand sorted so that size distributions of the two treatment groups were as similar as possible (see Appendix I). Equal numbers of both groups were transported in aerated tanker trucks and stocked concurrently by hand at all four lakes in June or July when fish were one year old and averaged 90-120 mm TL. Lake physical attributes and stocking information are summarized in Table 1 below.

Table 1. Stocking schedule and rates for westslope cutthroat trout planted in Clearwater Basin lakes during the study period.

			Number Stocked		*Year Stocked (X)*				
Lake	**Elevation (ft)**	**Acres**	**# Diploid**	**# Triploid**	**2011**	**2012**	**2013**	**2014**	**2015**
Rainy	4,786	103	1,000	1,000	-	X	X	X	X
Hidden	4,094	81	750	750	X	X	X	X	X
Clearwater	4,268	34	500	500	X	X	X	X	X
Spook	5,620	16	500	500	X	-	X	-	X

Collection of WCT Samples to Evaluate Survival and Performance

We evaluated the growth and survival of stocked fish in 2014 and 2015, after multiple year classes of fish marked for the trial had been planted in study lakes and given time to interact, grow, and mature. Cutthroat trout samples were collected from all lakes between August 25 and September 15 using standard gill-netting procedures as described below.

Experimental gill nets used for the surveys were 6 ft (1.8 m) in height and 125 ft (38.1 m) in length. Nets were assembled with 5 panels of graduated monofilament mesh with ¾ in, 1 in, 1¼ in, 1½ in, 2 in (1.9 cm, 2.5 cm, 3.2 cm, 3.8 cm, 5.1 cm) bar measurements. Floating gill nets remained at the surface and extended 6 ft (1.8 m) down in the water column. Sinking gill nets rested on the lake bottom and extended 6 ft (1.8 m) towards the surface. Sampling in all lakes included both floating and sinking nets, but consisted predominantly of floating nets (55-70%). Floating nets were most often deployed in shallower water depths < 20 ft (6.1 m) and sinking nets were generally set where water depths exceeded 20 ft (6.1 m). Nylon ropes were used to attach floats and 10 lb (4.5 kg) anchors at each end. Net orientation differed slightly by site, but typically sets were perpendicular to the shoreline with the smallest mesh panels near shore.

We attempted to standardize net locations, net type, soak time, and timing of sampling in both years. Total netting effort ranged three to six nets in each lake that were all set overnight. Nets were deployed at multiple sites around the lake perimeter where high catch rates were anticipated. Sets began between 1600 and 2000 and nets were recovered between 0700 and 1200 the following day.

Figure 3. Floating gill net (left) used to collect samples of westslope cutthroat trout (right) from study lakes.

Fish were extracted during net retrieval and bagged separately to distinguish catch among sites and net types. WCT from each net were measured (TL, mm), weighed (g) and identifying marks (adipose fin intact or removed) were noted to distinguish diploid and triploid individuals. Vertebrae were then extracted from all diploid WCT, placed in individual envelopes, and later examined under a black light to determine if any individuals were naturally produced in the lake (no OTC mark). WCT that lacked an adipose fin clip and an OTC mark on vertebrae were assumed to be wild and not part of the paired trial.

Comparison of Catchability for Diploid and Triploid WCT

We evaluated the relative catchability of diploid and triploid WCT at Spook Lake, which was selected because no natural WCT reproduction was evident, stocked WCT were abundant, and the lake is easily accessible. We angled for cutthroat trout on three separate occasions in summer and fall of 2016 (June, July, September).

Individual anglers captured fish using flies, bait and hardware from shore and various watercraft on the three dates noted above. Upon capture, WCT were measured and adipose fins were examined. Individuals with a clipped adipose fin were identified as triploid (sterile), while those with no clip were assumed to be stocked diploid fish. Metadata and information for all fish was recorded on a datasheet by each angler. All data were later tabulated for each fishing date, along with total time angled, to calculate cumulative catch rates.

Results and Discussion

All four study lakes were sampled in late summer of 2015 to evaluate the performance of previously stocked diploid and triploid WCT. All WCT netted in Hidden and Spook Lakes were marked and the lakes appeared to conform to our assumption of insignificant natural reproduction (Figure 4). As expected based on prior sampling, some of the WCT netted in Clearwater Lake (~30%) were unmarked, naturally produced fish that were eliminated from our paired comparisons.

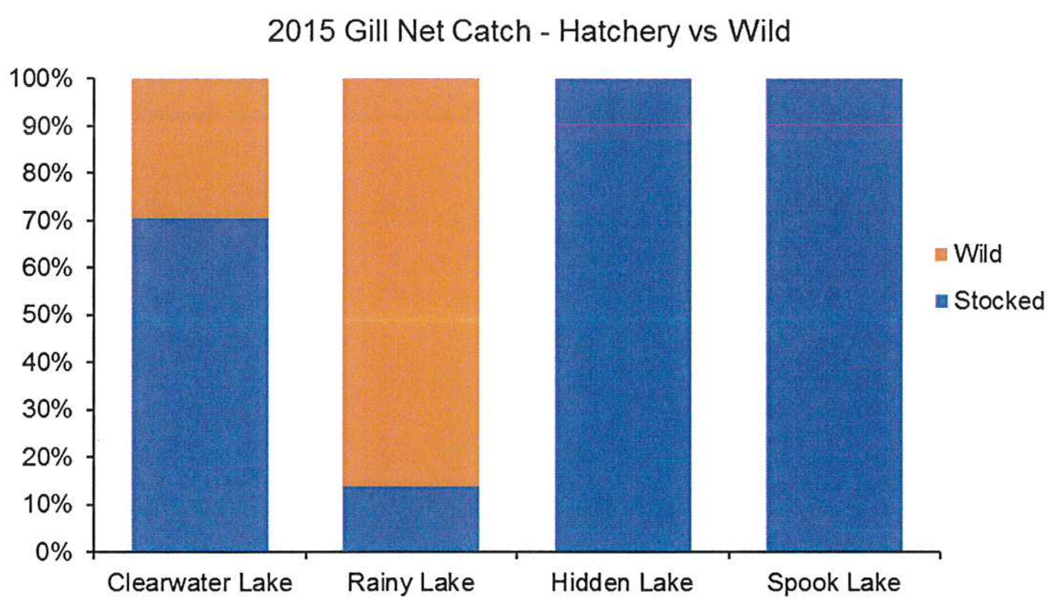


Figure 4. Relative proportion of wild and stocked (hatchery) westslope cutthroat trout captured in gill net surveys conducted at study lakes in 2015.

The WCT composition in Rainy Lake was much different than we expected. Only ~15% of the WCT we sampled in 2015 were stocked fish considered part of the trial, despite four consecutive years of stocking and the highest total numbers of WCT planted in any lake (Figure 4). These results indicated that we vastly underestimated the amount of WCT natural reproduction occurring in the East Fork Clearwater River and other tributaries of Rainy Lake. Therefore, we terminated the evaluation of paired trials at Rainy Lake in 2015 and focused efforts on the three remaining study lakes in 2016.

Comparison of Growth, Condition and Survival

Comparison of survival rates for stocked diploid and triploid WCT indicated substantial differences among lakes and sampling periods (Figure 5). Survival was significantly higher ($p < 0.05$) for diploid WCT in both years at Hidden Lake and in 2016 at Spook Lake, while no significant differences were observed in either year at Clearwater Lake. Netting results were somewhat complicated by the number of wild WCT captured in Clearwater Lake.

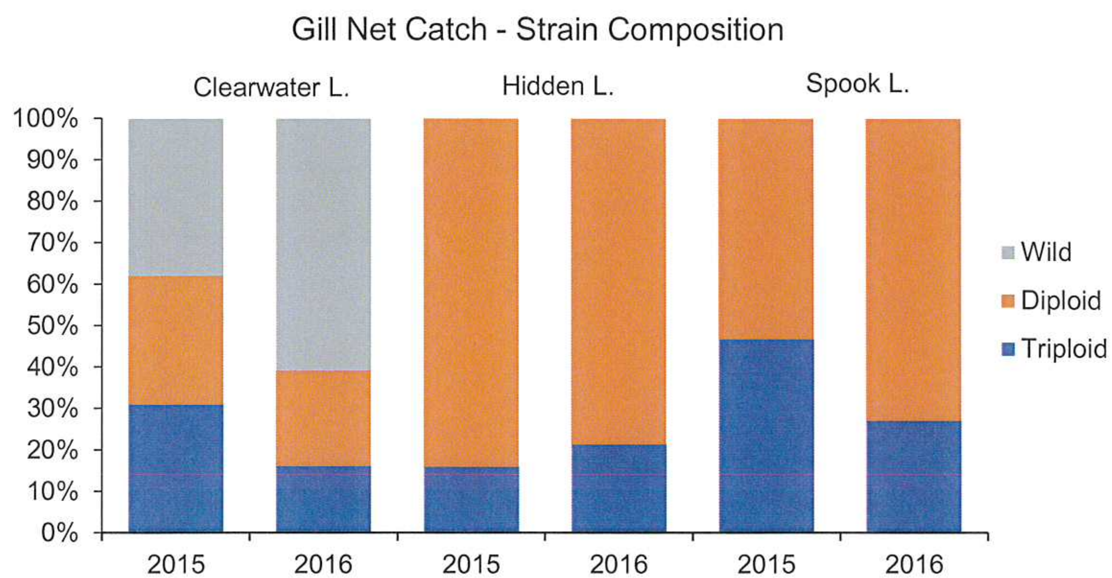


Figure 5. Composition of gill net catch for westslope cutthroat trout sampled in Clearwater, Hidden and Spook Lakes in 2015 and 2016.

We detected no significant differences in growth rates between sterile and viable WCT in any of the lakes, as illustrated by size-frequency distributions for fish captured in gill nets (see Appendices II-IV). Comparable growth rates for sympatric triploid and diploid rainbow trout (*Oncorhynchus mykiss*) were also reported by Koenig and Meyer (2011) and Teuscher et al. (1993) in Idaho lake and reservoir trials. These and other studies suggest that purported growth advantages for triploid trout in put-grow-and-take fisheries are inconsistent or incorrect.

In contrast, average fish condition as measured by relative weight (Wr) was consistently lower for triploid WCT in Spook Lake and Clearwater Lake, and these differences were statistically significant ($p<0.05$) in both years at Spook Lake (Table 2). The mechanisms responsible for consistently lower body condition observed for triploid WCT are not clear. However, various reports have suggested that modified haematology and metabolic processes in triploid fish, particularly under stressful environmental conditions (e.g., high water temperature), likely contribute to observed differences in body condition (Ojolick et al. 1995; Simon et al. 2011).

Table 2. Comparison of condition (Wr) for stocked diploid and triploid westslope cutthroat trout captured in Spook Lake and Clearwater Lake.

	Diploid				Triploid			
	Mean (W_r)	SD	Length Range (mm)	n	Mean (W_r)	SD	Length Range (mm)	n
Spook Lake 2015	**100.4***	11.8	284-411	25	**93.5***	8.4	270-406	22
Spook Lake 2016	**107.8***	9.3	276-462	57	**99.8***	6.5	276-449	22
Clearwater Lake 2015	**99**	5.3	267-332	9	**98**	7.3	280-353	9
Clearwater Lake 2016	**102.5**	8.1	293-416	17	**99.7**	5	291-398	12

* Difference in condition (W_r) values is statistically significant ($p<0.05$)

Comparison of Catchability by Anglers

The relativel catchability of diploid and triploid WCT was evaluated at Spook Lake in 2016. Experienced volunteer anglers used a variety of gear types to catch a total of 139 WCT (~ 150-425 mm) while fishing on three different days in summer and early fall. Pooled catch rates ranged from 1.1 to 2.2 WCT per hour for anglers fishing on each date.

Figure 6. Volunteer anglers on Spook Lake comparing catchability of stocked diploid and triploid westslope cutthraot trout.

The cumulative angler catch for triploid WCT was slightly higher than the proportion of diploid WCT (Figure 7, right chart). This was surprising, given that approximately 2/3 (63%) of the remaining WCT in the lake were diploid based on random gill net sets (Figure 7, left chart). These results could suggest that either diploid WCT are more susceptible to gill nets (unlikely) or that triploid WCT are more susceptable to angling. Regardless of whether catchability was actually significantly higher for triploid individulas in our study, it is clear that triploidy did not result in behavioral differences that were adverse to angling or angler success in Spook Lake.

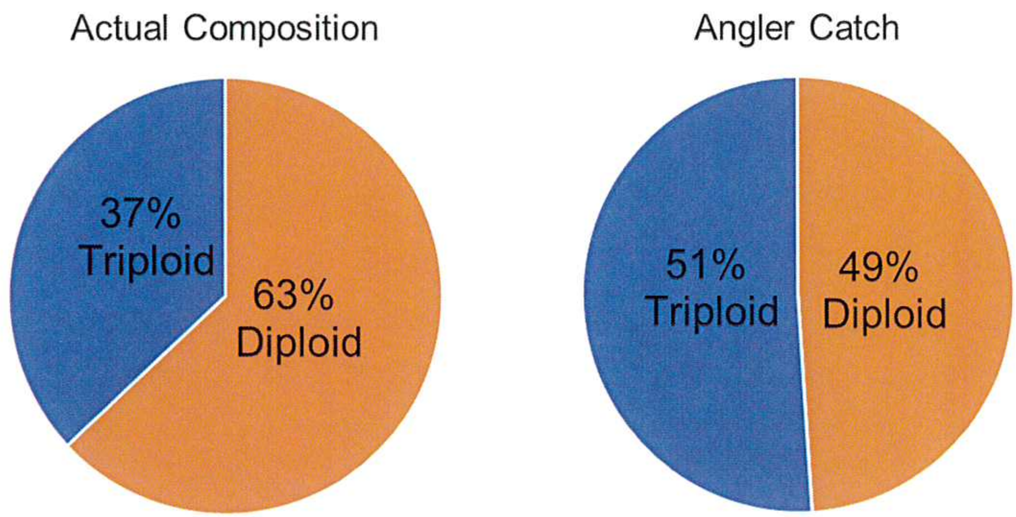


Figure 7. Comparison of actual westslope cutthroat trout strain composition from gill net surveys (left) and cummulative composition of angler catch for Spook Lake (right) in 2016.

Conclusions

Sterile (triploid) trout provide a feasible stocking alternative in situations where viable (diploid) hatchery fish may pose a threat to the genetic integrity of wild populations. Results of this study indicate that, in some instances, performance tradeoffs for stocked triploid WCT are likely lower body condition and survival relative to diploid individuals. These tradeoffs appear to be more prevalent when fish experience stressful environmental conditions (e.g., high water temperatures or low oxygen). However, based on our limited sample, catchability of triploid WCT was as high and possibly higher than that observed for comparable diploid fish. This quality may help to compensate for reduced performance and potentially higher mortality in fisheries supported by stocked triploid WCT. Results also suggest that somewhat higher stocking rates may be warranted for triploid trout in situations where higher mortality is observed or anticipated.

Acknowledgments

This study would not have been possible without the commitment and efforts of the Washoe Park Fish Hatchery staff. Thanks also to the members of West Slope Chapter Trout Unlimited who contributed their time and angling expertise on the cutthroat trout catchability portion of this study. Caleb Uerling reviewed and improved earlier drafts of the report.

References

Boyer, M.C., G. Michael, M. Schnee, L. Fried, K. Tempel, and S. Relyea. 2012. Hungry Horse Mitigation Program 2011 Annual Report. BPA Project Number 199101903. Montana Fish, Wildlife & Parks, Kalispell, Montana.

Koenig, M.K., J.R. Kozfkay, K.A. Meyer, and D.J. Schill. 2011. Performance of Diploid and Triploid Rainbow Trout Stocked in Idaho Alpine Lakes. North American Journal of Fisheries Management 31:124-133.

Koenig, M.K. and K.A. Meyer. 2011. Relative Performance of Diploid and Triploid Catchable Rainbow Trout Stocked in Idaho Lakes and Reservoirs. North American Journal of Fisheries Management 31:605-613.

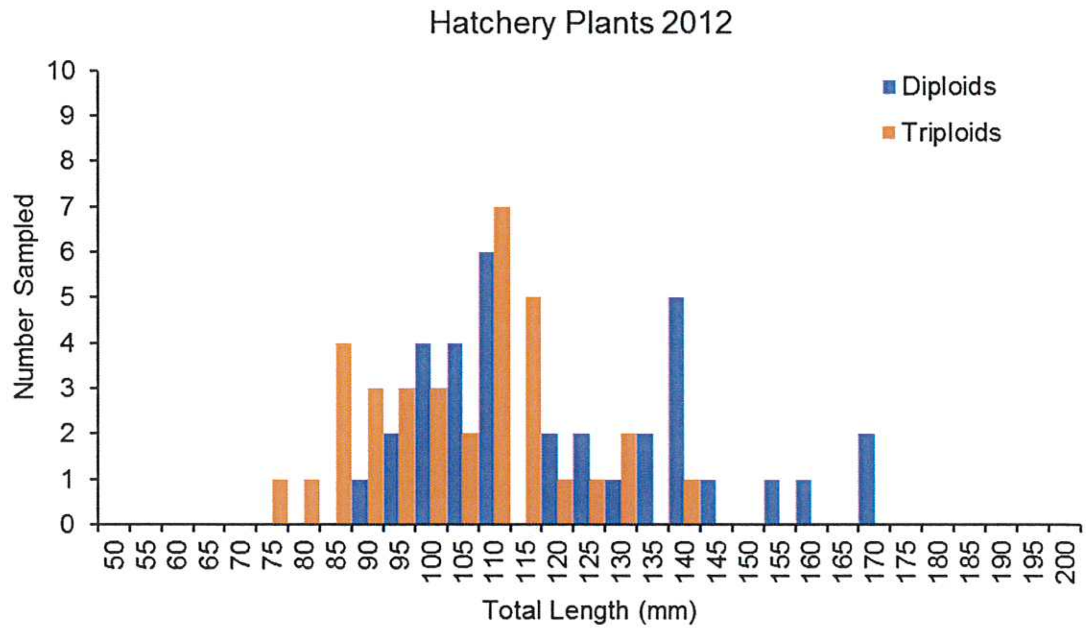
Kozfkay, J.R. J.C. Dillon, and D.J. Schill. 2011. Routine Use of Sterile Fish in Salmonid Sport Fisheries: Are We There Yet? Fisheries 31:392-401.

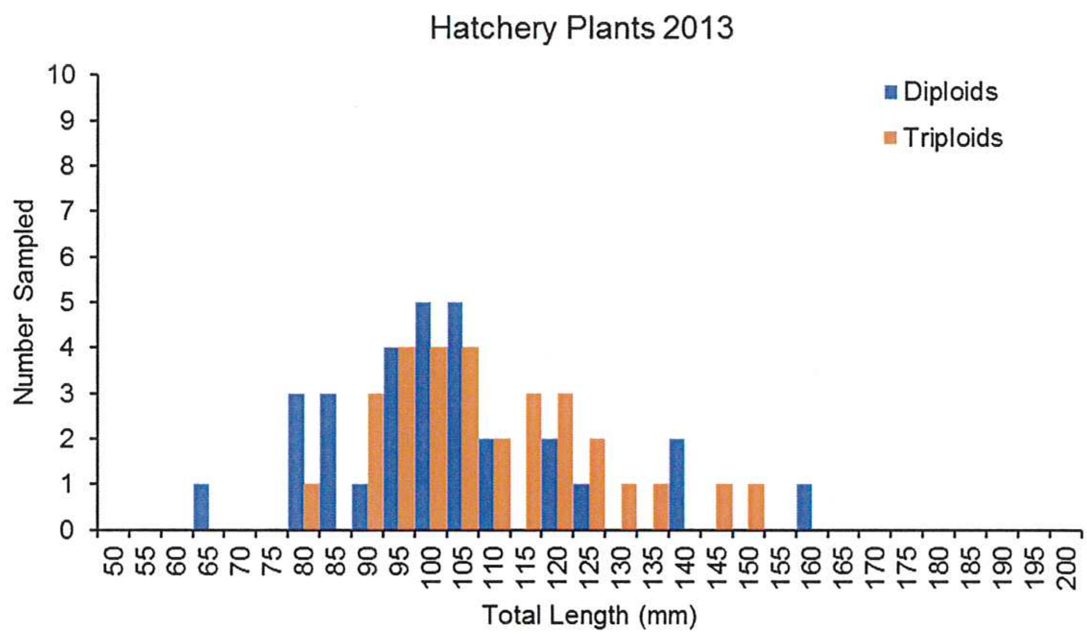
Ojolick, E.J. R. Cusack, T. Benfrey, and S.R. Kerr. 1995. Survial and Growth of All-Female Diploid and Triploid Rainbow Trout (Oncorhynchus mykiss). Aquaculture 131(3-4):177-187.

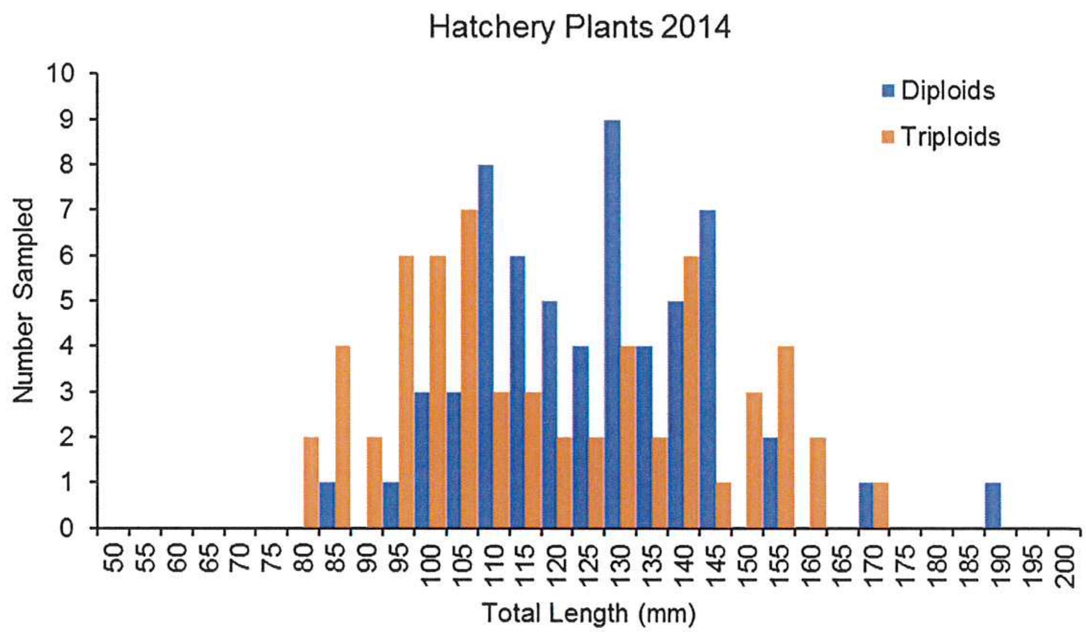
Simon, D.C., C.G. Scalet, and J.C. Dillon. 2011. Field Performance of Triploid and Diploid Rainbow Trout in South Dakota Ponds. North American Journal of Fisheries Management 13:134-140.

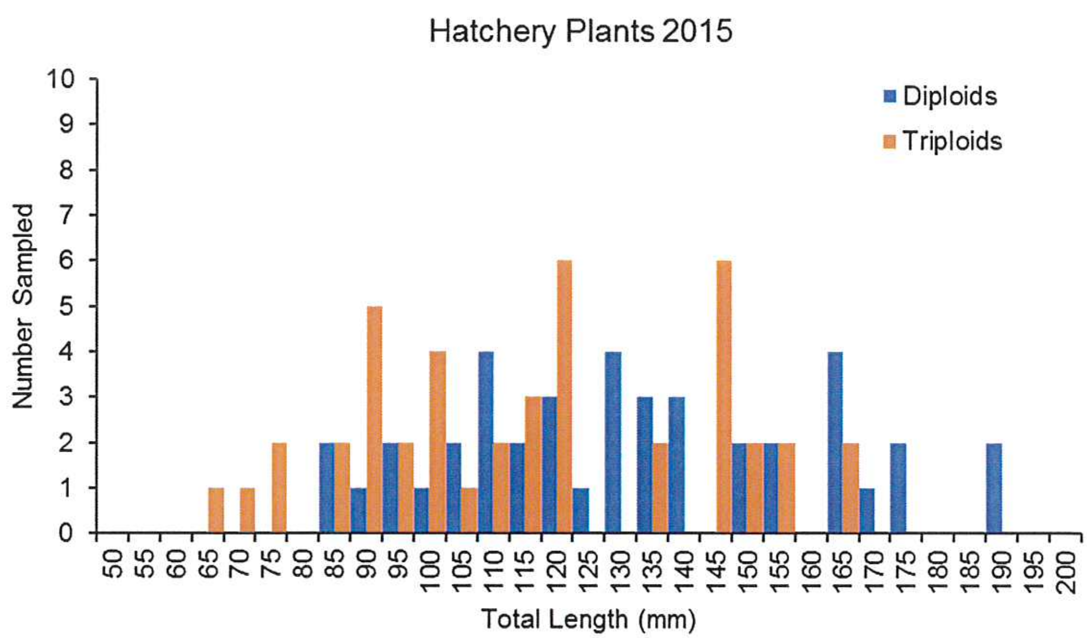
Teuscher, D.M., D.J. Schill, D.J. Megargle and J.C. Dillon. 2003. Relative Survival and Growth of Triploid and Diploid Rainbow Trout in Two Idaho Reservoirs. North American Journal of Fisheries Management 23:983-988.

Appendix I. Size distributions of diploid and triploid WCT at time of stocking in Clearwater Basin lakes in 2012-2015.

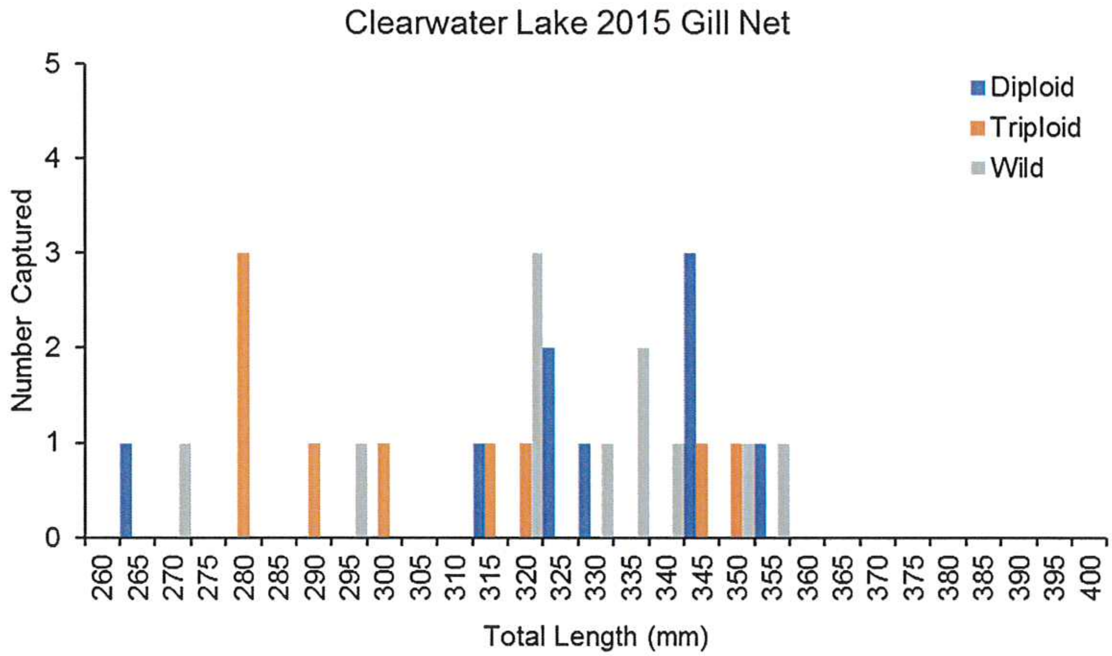


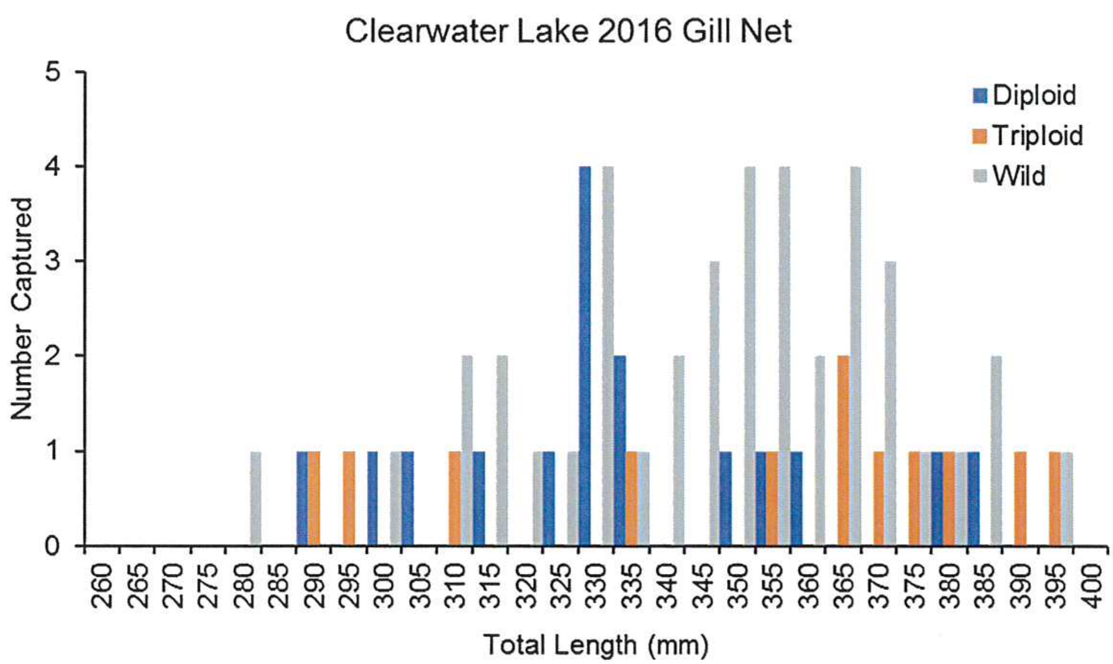



Hatchery Plants 2014
Diploids
Triploids
Number Sampled
Total Length (mm)
10
9
8
7
6
5
4
3
2
1
0
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180
185
190
195
200

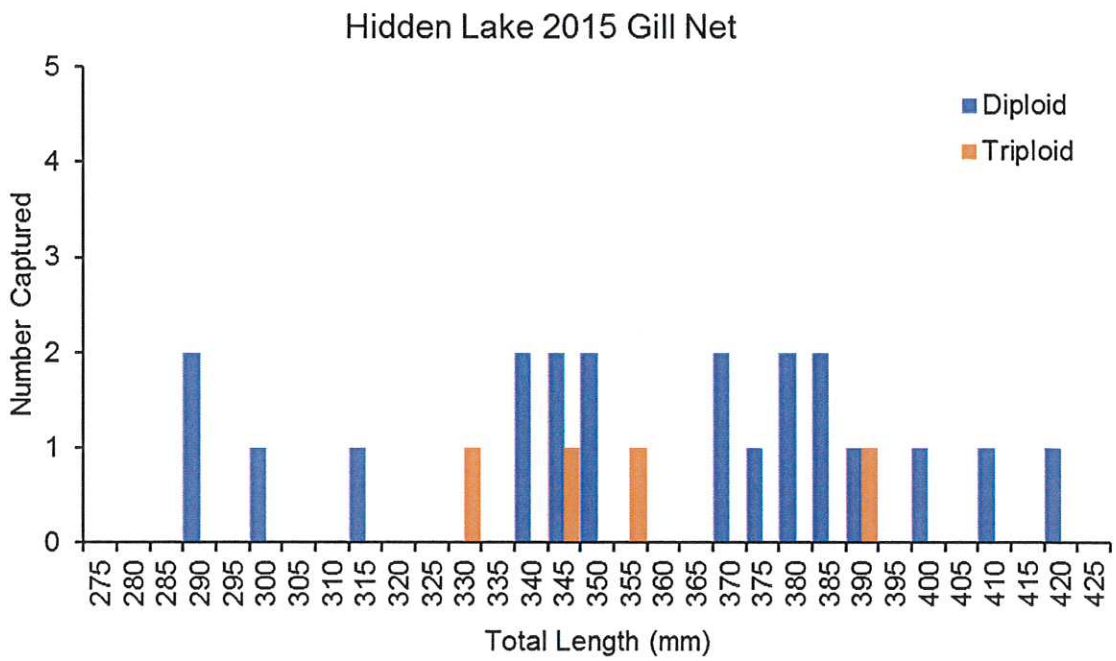

Hatchery Plants 2015
Diploids
Triploids
Number Sampled
Total Length (mm)
10
9
8
7
6
5
4
3
2
1
0
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180
185
190
195
200

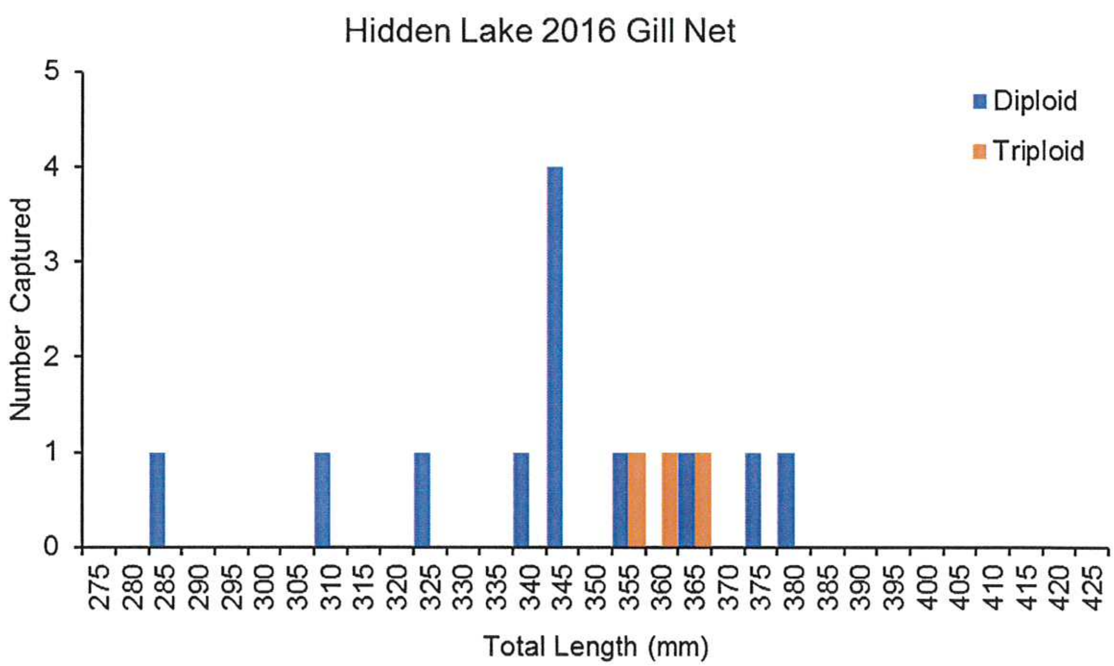
Appendix II. Size distribution and strain composition of westslope cutthroat trout sampled in Clearwater Lake in 2015 (top) and 2016 (bottom).





Appendix III. Size distribution and strain composition of westslope cutthroat trout sampled in Hidden Lake in 2015 (top) and 2016 (bottom).





Appendix IV. Size distribution and strain composition of westslope cutthroat trout sampled in Spook Lake in 2015 (top) and 2016 (bottom).